

# Traffic Engineering

## Past, Present and Future?

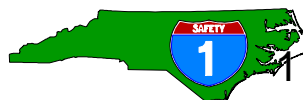
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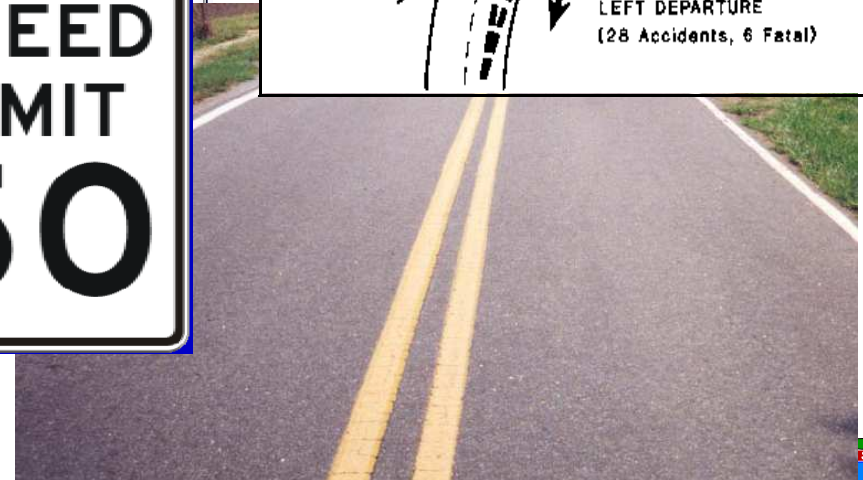
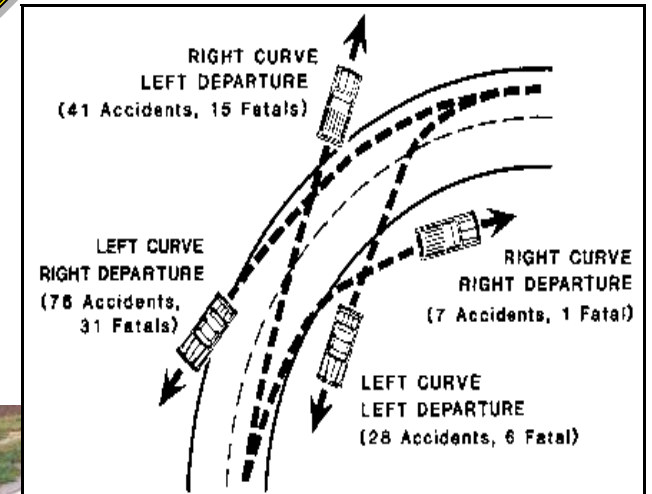
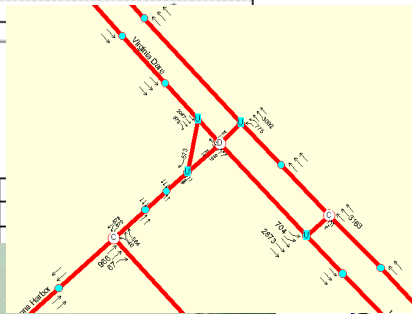
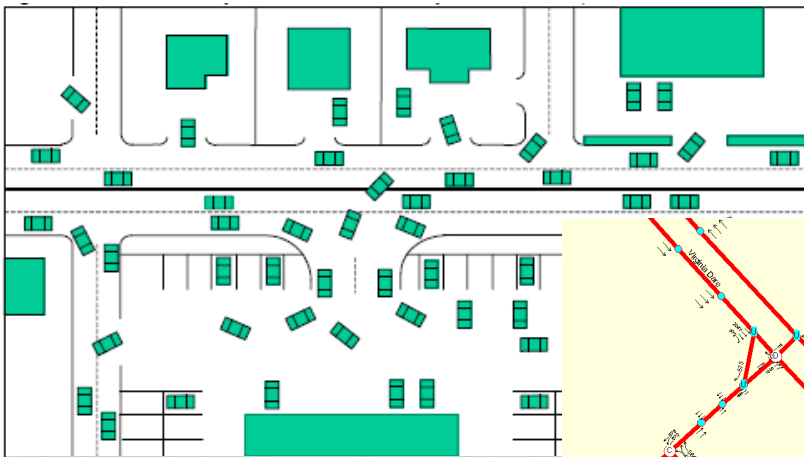
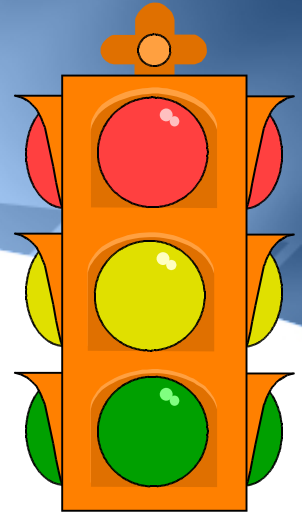
(919) 733-3915

August 25, 2006



# Traffic Engineering

## What is Traffic Engineering?



# Traffic Engineering

Traffic Flow

Traffic Management

Parking

ITS

Traffic Studies

Investigation

Pedestrians

Bicycles

Interchange Design

Weaving Analysis

Sidewalks

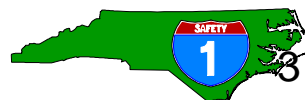
Traveler Information

Special Events

Trucks

Crash Recon.

Etc...



# Traffic Engineering

Well How did we get where we are today?

Signals

Signs

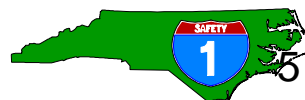
Pavement Markings

ITS



# The First Traffic Signal

- Installed on December 10, 1868 in London England
- Used a revolving red and green gas lantern
- GREEN meant CAUTION RED meant STOP
- Required manual operation



# The First Traffic Signal

- January 2, 1869 it exploded injuring the police officer operating the signal.
- *Operated for 24 days*



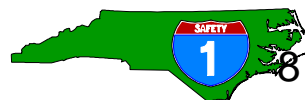
# RED, YELLOW and GREEN

- Adapted from Railroad Signals
- Red - STOP
- White - GO
- Green - CAUTION
- Problem was if a lens was lost a white light shone. **This was obviously a recipe for disaster.**
- Green's meaning was changed from caution to go and yellow replaced green for the caution stage.



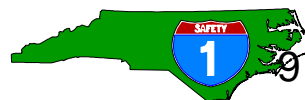
# An Acceptable Signal

- Originally Semaphore
- 1908 - manual semaphore in Toledo, Ohio
- 1910 - failed attempt of elect semaphore with no record of actual installation
- 1913 - mechanical semaphore in Detroit
- 1914 - first electronic traffic signal developed by James Hoge in Cleveland  
Red and Green Lights with a bell to indicate a change



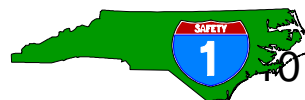
# An Acceptable Signal

- 1920 - first Red, Yellow, and Green light in Detroit
- 1923 - Garrett Morgan patented a traffic signal device that was the first automatic traffic signal in Cleveland
- (1922) another source indicated that the first automatic signal was in Houston



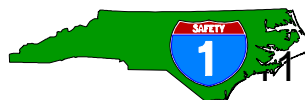
# Coordinated Signals

- 1917 - The first interconnected traffic signal system was installed in Salt Lake City Utah with six connected intersections controlled simultaneously from a manual switch.
- Henry Barnes - Credited with the creation of the “GREEN WAVE”.
  - He also the creator of the Barne Dance the all stop Pedestrian Phase (1940)



# Traffic Signals Today

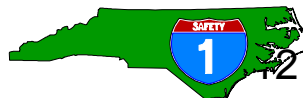
- Over 300,000 nationwide
- Electronic controls replaced electromechanical controls.
- LED displays replaced incandescent bulbs.
- Flashing Yellow Arrows
- Advanced Controllers
- Municipal Signal Systems
- Traffic Responsive Systems
- Preemption



# Traffic Signals Today

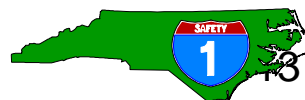
Today the simple part is making it turn red, yellow and green.

Maintaining communications, integrating equipment, maintaining timing plans, keeping track of various manufactures, developing and keeping skilled personnel to manage and maintain the equipment are some of our challenges today.



# Traffic Signals What is Next?

- Single LED Heads with Different Shapes?
- Direct communications between the intersection and the vehicle?
- How about improved traffic responsiveness?
- Improved detectors?



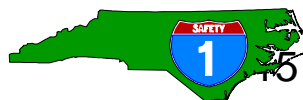
# Traffic Signs

- The original guide signs were the stars and geographical features.
- The Romans created mile markers and guide signs on their roads?
- The Colonials also had some stone signs



# Traffic Signs

- Do you think they had a sign directing people to the Mall or Camp Challenge?
- Probably Not - they were concern with sign proliferation.



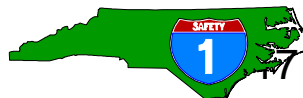
# Traffic Signs

As motor vehicles became more common so did traffic signs.



# Traffic Signs

- Wisconsin was the first state to use the number road system. They started in 1918.
- 1922 the New England States got together and established a six state New England Interstate Routes.
- April 1925 the U.S. Highways was adopted along with the familiar US Highway Shield.
- As can be expected, some did not like the idea especially the auto clubs who preferred highway names.



# Traffic Signs

- 1923 - The Mississippi Valley Association of Highway Departments developed some consistency.
- 1924 - The National Conference on Street and Highway Safety.

Red - Stop

White - Directions or Dist.

Green - Proceed

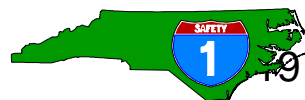
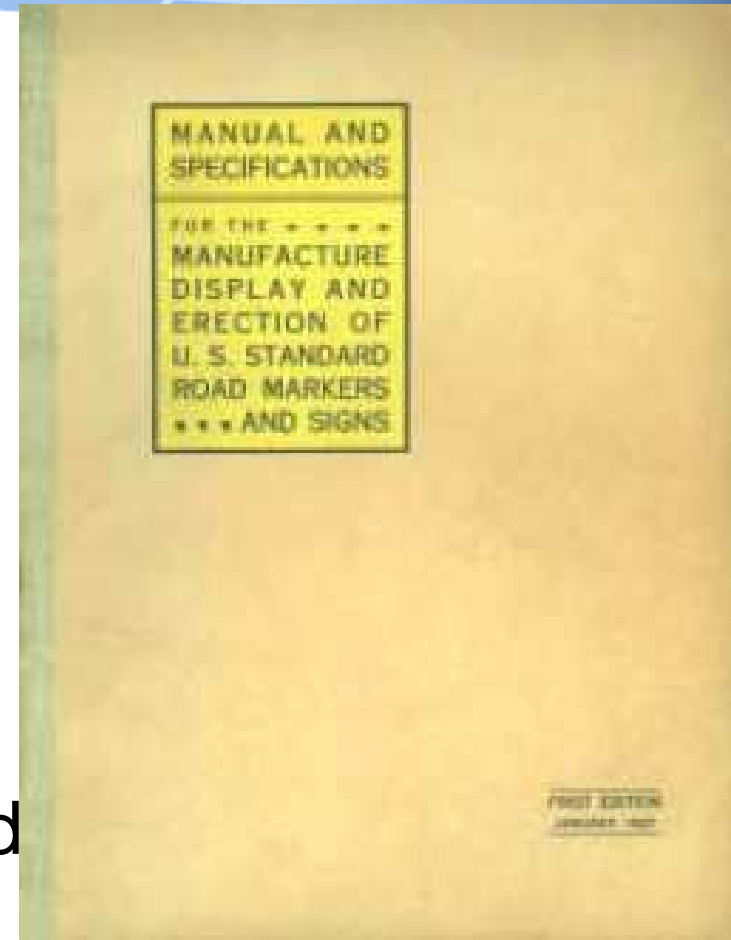
Purple - Intersection

Yellow - Caution



# Traffic Signs

- 1925 - AASHTO led report recommended some standard signs.
- 1927 - Manual and Specifications for the Manufacture, Display and Erection of U.S. Standard Road Markers and Signs
- For Rural Roads

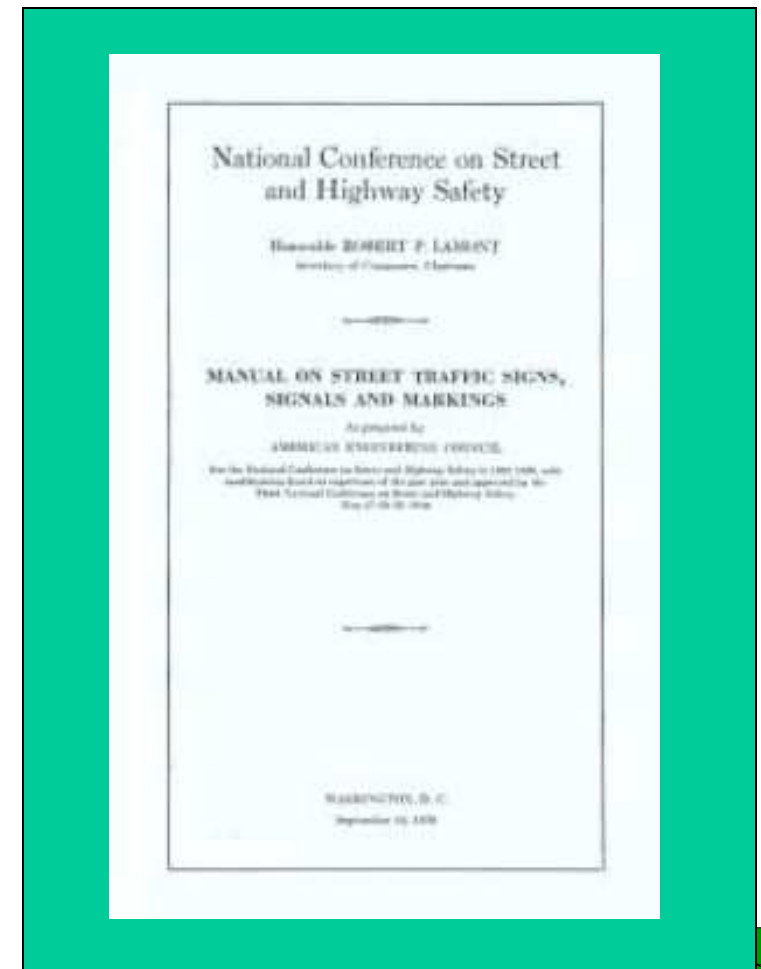


# Traffic Signs



# Traffic Signs

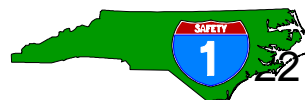
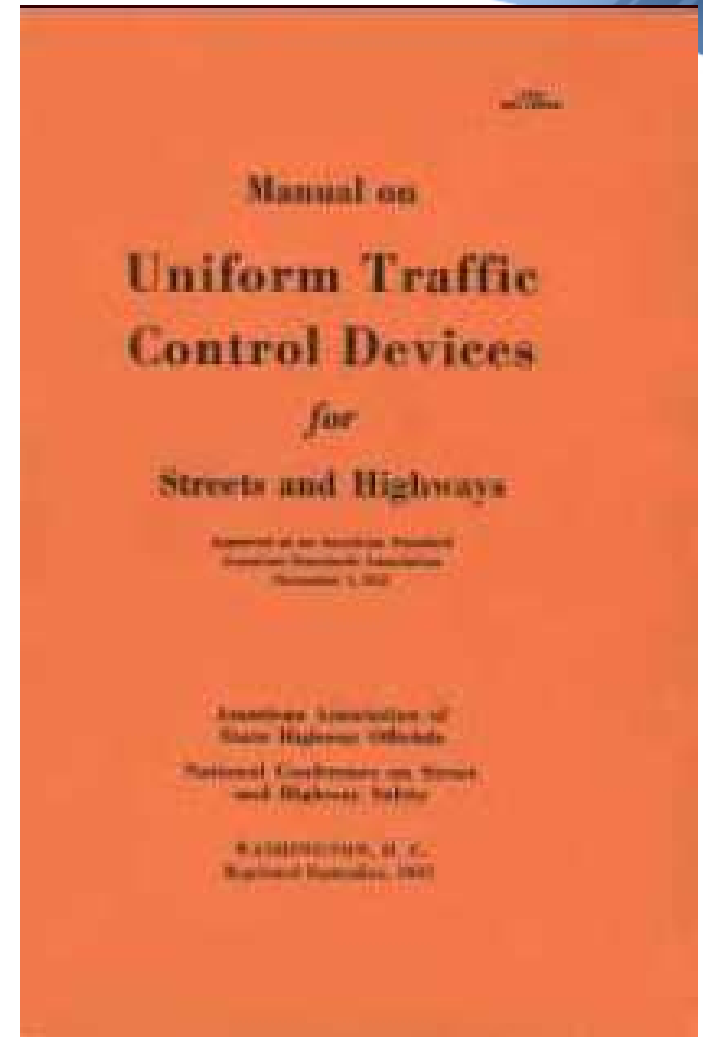
- 1930 - National Conference on Street and Highway Safety Manual on Street Traffic Signs, Signals, and Markings
- Used for Urban Areas



# Traffic Signs

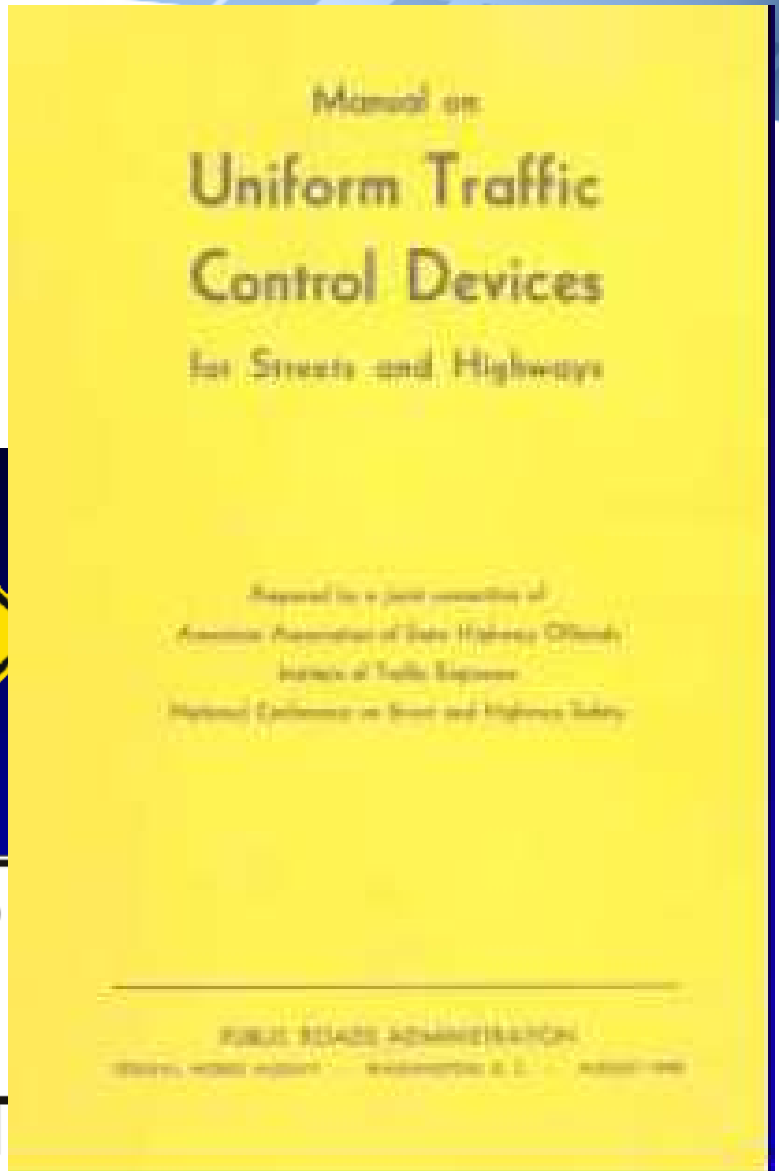
These early manuals and attempts for standardization lead to the first Manual on Uniform Traffic Control Devices for Streets and Highways Published in 1935 and 1937

- Regulatory signs were white rectangle
- Warning - Yellow Diamond, Square, circle or octagon
- Guide Signs - white rectangles



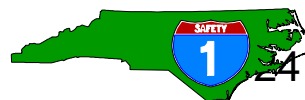
# Traffic Signs

- 1948 version used bold text, simplified text messages, added advisory plates, and used rounded alphabet,



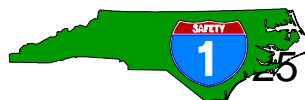
# Traffic Signs

- 1954 revision of the MUTCD had significant sign changes, STOP signs took on the current look, removed secondary messages and a new YEILD sign was added.



# Traffic Signs

- 1958 MUTCD had major changes and was created for the Interstate System. White on Green Guide Signs, lower case letters, with GREEN on White Service signs.
- 1961 added Blue service signs, required compliance required and allowed some symbol signs.




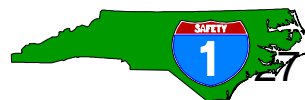
# Traffic Signs

1961



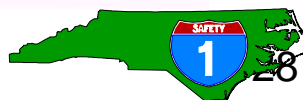
# Traffic Signs

- 1971 Manual had many new symbols added. This was do to the influence of international signs
  - 1971 version had eight (8) revisions
- 
- A collage of various traffic signs. In the top left is a red inverted triangle with a white center and the word 'YIELD' in red. Below it is a red circle with a white horizontal bar and the words 'DO NOT' above and 'ENTER' below in red. To the right of the yield sign is a yellow diamond sign featuring a black traffic light symbol with red, yellow, and green lights. Further right is a yellow diamond sign with the words 'STOP AHEAD' in black. Below the 'DO NOT ENTER' sign is a yellow pentagon sign with a black silhouette of two pedestrians. To the right of that is a yellow diamond sign with a black silhouette of a single pedestrian. The signs are set against a dark blue background.



# Traffic Signs

- 1978 MUTCD added more new signs and symbolic messages.
- This version was revised 4 times



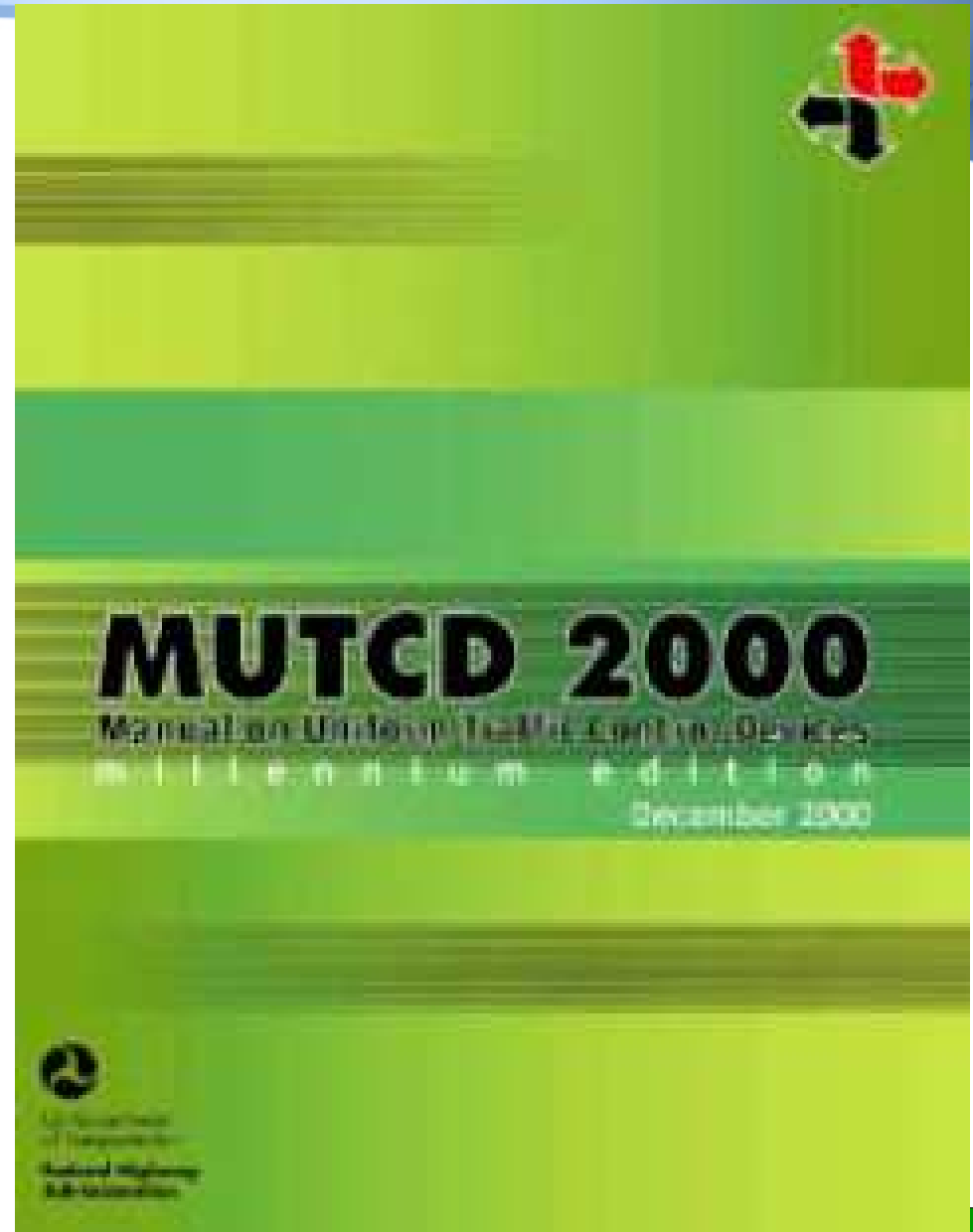
# Traffic Signs

- 1988 MUTCD Planned to be revised only for safety reasons
- Recreational and Cultural Signs
- Logo and TODS Signs
- This version was revised 7 times



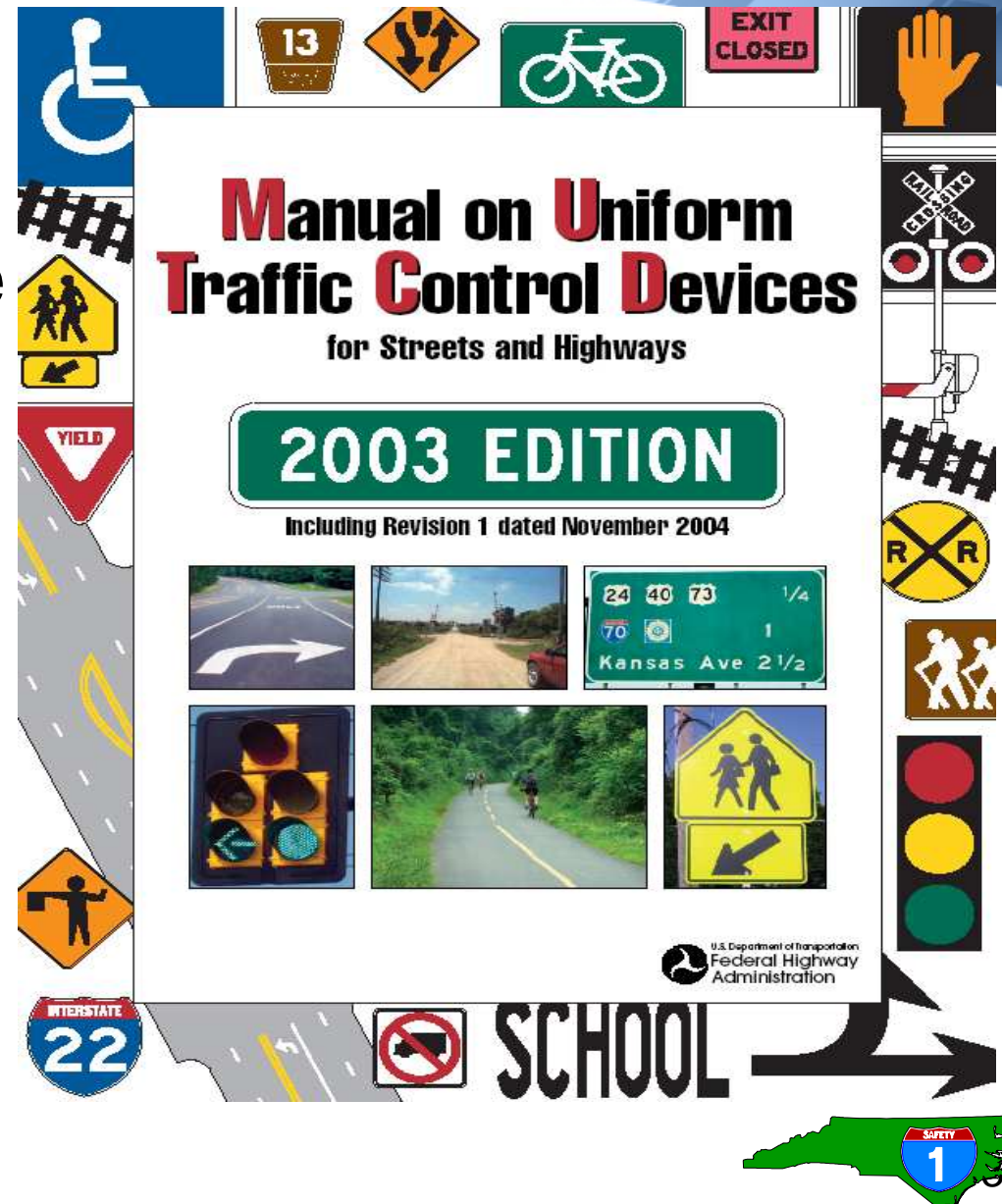
# Traffic Signs

- 2000 MUTCD took 10 years to develop
- Numerous problems
- Short Lived Version



# Traffic Signs

- 2003 MUTCD
- Corrected many of the problems with the 2000 version

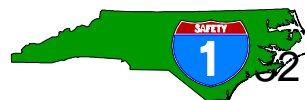


# Traffic Signs in the Future

Where are we going with traffic signs?

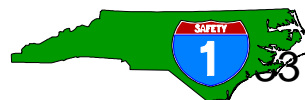
Signs that provide information directly to the vehicle to help control the vehicle? (Speed)

Signs that provide information to a intelligent vehicle or provide information on services?



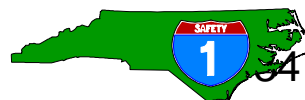
# Pavement Markings

1911 - first center line in Michigan



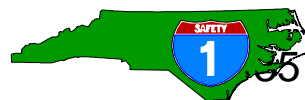
# Pavement Markings

- 1935 MUTCD used pavement markings at hazardous locations. White, Yellow or Black.
- 1948 MUTCD
  - Double Yellow center and barrier line
  - White for all other locations
  - Edge Lines not recommended
  - Stripe to gap ratio 15-25



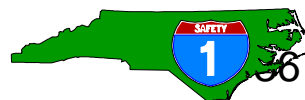
# Pavement Markings

- 1961 MUTCD - allowed edge lines
- 1971 MUTCD - standardized yellow markings for opposing traffic
- 1978 MUTCD - Yellow markings for left side, and changed the stripe to gap ratio 10-30



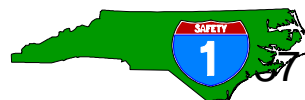
# Raised Pavement Markers

- 1936 Some records indicate that CALTRANS was discussing raised pavement markers.
- 1939 - Cat's eyes were patented
- 1953 - CALTRANS Starts Research on a raised pavement marker
- Dr. Elber Dvsart Botts with CALTRANS led research on the markers and an epoxy to attach them too the roads



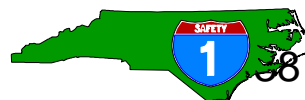
# Raised Pavement Markers

- This lead to the invention of Bott's Dots.
- 1966 California legislature mandated that Botts dots were to be used for lane markings for all state highways except in areas where it snowed in the winter.
- There are more than 25 million Bott's Dotts



# Raised Pavement Markers

- October 1964 Sidney Heenan applied for a patent for the modern raised pavement marker.
- Later improvements created the snow plowable markers

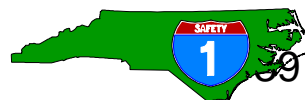


# Pavement Markers in the Future

Will they all be one color?

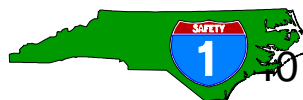
Will we ever develop an effective wet marking system that is cost effective and easy to maintain?

Will they be used by intelligent vehicles for guidance?



# ITS

- 1970 - Electronic Route Guidance System ERGS. This was an in-vehicle navigational and route system.
- 1990 - Mobility 2000 established vision and encouraged Intelligent Vehicle Highway Systems (IVHS).



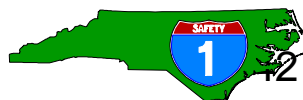
# ITS

- 1991 Formation of ITS America, passage of Intermodal Surface Transportation Efficiency Act that provided encouraged development and demonstration projects.
- 1994 - National ITS architecture that defined national ITS structure for interoperability



# ITS

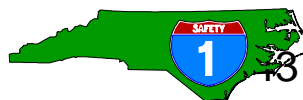
- 1997 - Automated Highway Demonstration in San Diego.
- ITS applications have expanded to all parts of transportation. The broadest definition covers items beyond the function of the transportation network



# ITS - Today

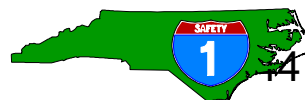
The ITS program are a set of related technologies that include the following:

- Archived data
  - archived data mart
  - archived data warehouse
  - archived data virtual warehouse



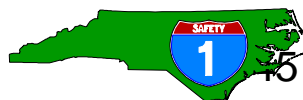
# ITS - Today

- Advanced Public Transit Systems
  - transit vehicle tracking
  - transit fixed-route operations
  - demand responsive transit
  - passenger and fare management
  - public travel security
  - transit maintenance
  - multi-modal co-ordination
  - en-route transit information
  - multi-modal connection protection



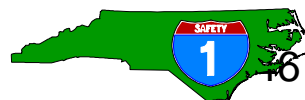
# ITS - Today

- Advanced traveler information systems
  - in-vehicle navigation system
  - variable messages signs (DMS, CMS)
  - broadcast traveler information
  - Transport Protocol Expert Group
  - Traffic Message Channel
  - Vehicle Information and Communication System
  - interactive traveler information
  - 511
  - autonomous route guidance
  - dynamic route guidance
  - ISP - based route guidance
  - traffic estimation and prediction



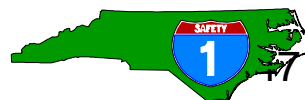
# ITS - Today

- traveler service payment and reservations
- ride matching
- in-vehicle signing
- RFID based intelligent traffic signs or road beacons
- Intelligent Speed Adaptation
- Floating Car Data



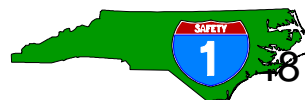
# ITS - Today

- Advanced Traffic Management Systems
  - ramp meters
  - traffic control
  - traffic network flow monitoring
  - probe-based flow monitoring
  - surface street control
  - highway control
  - HOV lane management
  - traffic information dissemination
  - regional traffic control
  - incident risk prediction system
  - predictive demand management
  - electronic toll collection
  - automatic number plate recog.



# ITS - Today

- virtual TMC and vehicle-based sensing
- emissions management
- at-grade crossing control
- modal operation co-ordination
- electronic parking
- reversible lane management
- road weather information
- roadway environmental sensing
- smart work zones
- dynamic roadway warning
- variable speed limit



# ITS - Today

- speed limit enforcement
- traffic signal management
- traffic signal enforcement
- mixed use warning systems
- automated non-vehicular road user protection



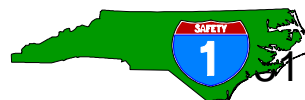
# ITS - Today

- Advanced Vehicle Safety Systems
  - vehicle safety monitoring
  - driver safety monitoring
  - longitudinal warning systems
  - lateral warning systems
  - intersection collision warning
  - pre-collision restraint deployment
  - sensor-based driving safety enhancement
  - longitudinal collision avoidance
  - lateral collision avoidance
  - intersection collision avoidance
  - automated vehicle operation



# ITS - Today

- Automated Highway Systems
- Commercial Vehicles Operations
  - fleet administration
  - freight administration
  - electronic clearance
  - commercial vehicle administrative processes
  - international border crossing clearance
  - weigh-in-motion (WIM)
  - roadside CVO safety



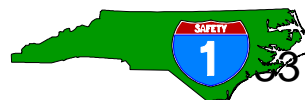
# ITS - Today

- on-board safety monitoring
- CVO fleet maintenance
- Hazardous material planning and incident response
- freight in-transit monitoring
- freight terminal management



# ITS - Today

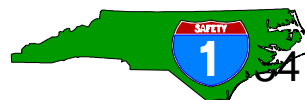
- Emergency Management Systems
  - enhanced 911
  - emergency response management systems
  - emergency vehicle routing
  - personal security and mayday support
  - freeway serviced patrols
  - disaster command and control
  - disaster information dissemination
  - e-Call
- Intelligent Vehicles
  - adaptive cruise control
- Automatic Vehicle Identification
- Automatic Vehicle Location



# Future Challenges

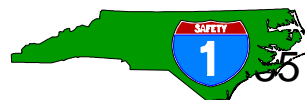
What are the challenges?

- Access management?
- Congestion Management?
- Safety?
- Systems Integration?



# Future Challenges

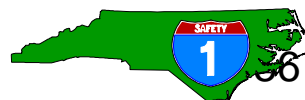
- Practitioners need to be involved in research, task forces, professional societies, etc.
- Practitioners need to comment on recommend changes to manuals, practices, guides, and other research
- The opportunity presents itself often



# Future Challenges

What happens if you do not participate in shaping the direction that our profession is heading?

- Impractical requirements
- Unnecessary liability
- more frustration



# Future Challenges

The one item that continuously ranks near the top of challenge has been the same one for the last 40 years or more

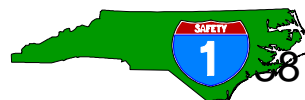
Workforce recruitment, retention and development.



# Workforce Recruitment

Recruiting students into our profession.  
This is a responsibility that we all have.

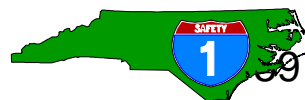
We are working on a false economy and  
have been for years. One day the  
retirees will go home and really retire.



# Workforce Retention

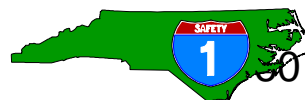
## Skill Set required

- can manage dynamic situations,
- deals with continued change in technology, tools and conditions,
- effectively works with the public in sensitive situations,
- effectively works with a diverse group of stakeholders.
- Requires the ability to apply a wide ranges of expertise and technology to solve complex problems.



# Workforce Development

- Training (formal and OTJ)
- Opportunity to apply skills
- Experience



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